

S-114-Cambridge

# B R E V I O R A

Museum of Comparative Zoology

US ISSN 0006-9698

CAMBRIDGE, MASS.

SEP 24 1973  
SEPTEMBER 20, 1973

NUMBER 410

HARVARD  
UNIVERSITY

## THE COLOR PATTERN OF *Sonora michoacanensis* (Duges) (SERPENTES, COLUBRIDAE) AND ITS BEARING ON THE ORIGIN OF THE SPECIES

ARTHUR C. ECHTERNACHT

**ABSTRACT.** The extensive variation in color pattern of the 31 known specimens of *Sonora michoacanensis* is described and a model illustrating the relationships of the major components presented. *Sonora aequalis* Smith and Taylor is placed in the synonymy of *Sonora michoacanensis mutabilis* Stickel from which it differs only slightly in color pattern. It is suggested that *S. michoacanensis* evolved from a bicolor, banded ancestor within the *S. semiannulata* group or from a common ancestor at the southern edge of the Mexican Plateau following habitat shifts associated with climatic changes during the Pleistocene. *Sonora michoacanensis* is interpreted as an imperfect Batesian mimic of elapid coral snakes (*Micrurus* sp.), intermediate in an evolutionary sequence beginning with the bicolor, banded ancestor and leading toward a more perfect, tricolor mimic. Known locality records of *S. michoacanensis* are mapped and selected meristic data presented in tabular form.

### INTRODUCTION

The genus *Sonora* (Serpentes, Colubridae) is represented in México, at the southern limit of its range, by *Sonora michoacanensis* (Fig. 1). *Sonora m. michoacanensis* (Dugès) is found in arid to semiarid habitats from the upper Balsas Basin in Puebla to the lower slopes of the Sierra de Coalcomán and southeastern Colima, whereas *S. m. mutabilis* Stickel occupies foothills of the Sierra Madre Occidental from southern Jalisco to Nayarit and Zacatecas (Duellman, 1961; Zweifel, 1956). The principal diagnostic difference between the subspecies is that *S. m. michoacanensis* has an unmarked tail, whereas the tail of *S. m. mutabilis* is banded. The two subspecies will be considered together in the discussion of color pattern to follow.

The last review of this assemblage was by Stickel (1943).

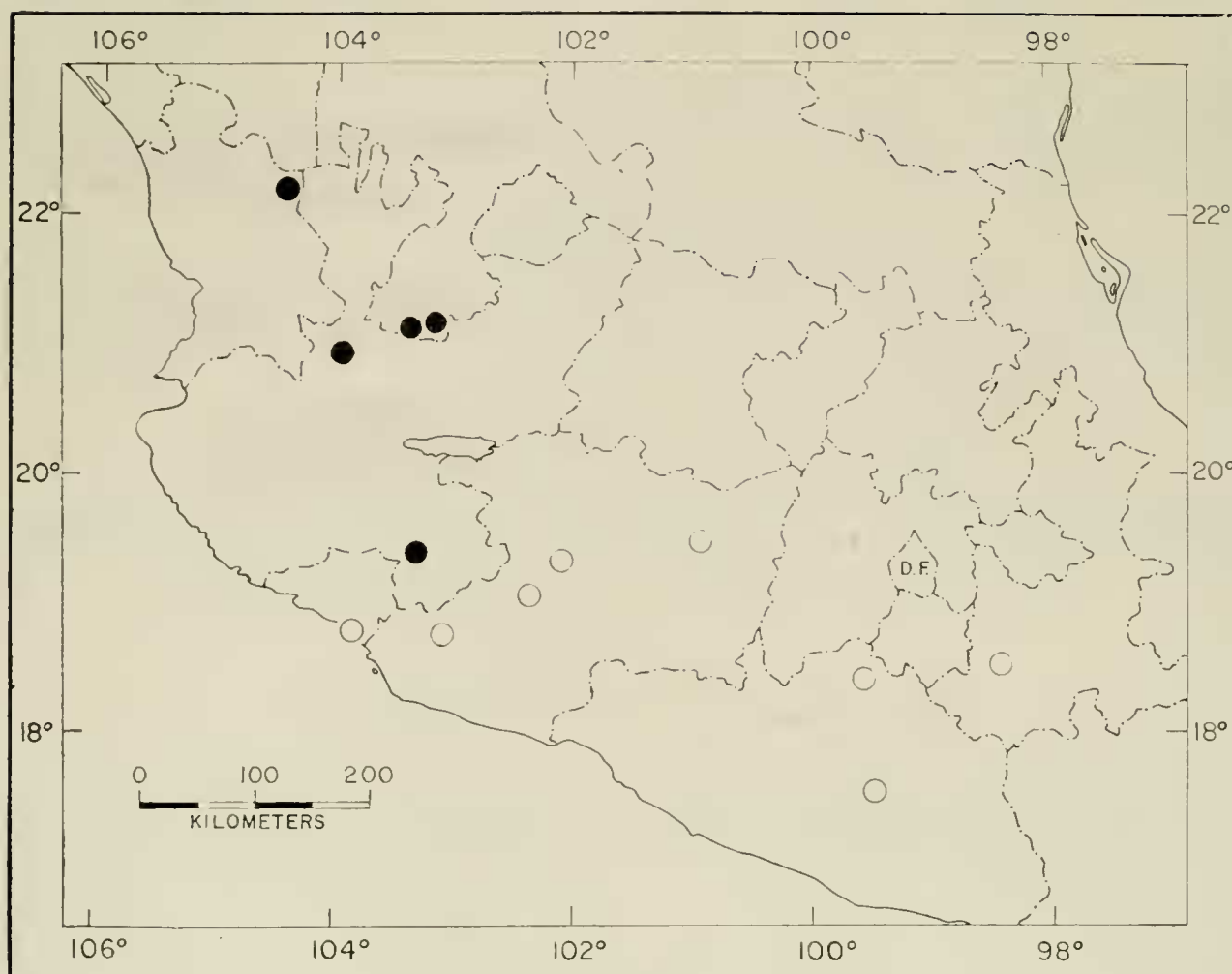


Figure 1. Localities of documented specimens of *Sonora michoacensis* in México. Hollow circles: *S. m. michoacensis*; solid circles: *S. m. mutabilis*. D. F. is the Distrito Federal.

His clear and concise discussion included a detailed description of a single unusual specimen which Smith and Taylor (1945) subsequently named, with no further description, *Sonora aequalis*. Stickel had been unwilling to base a new species on the single specimen because it was of unknown provenance and because it differed from *S. m. mutabilis* only in color pattern, a character known to be highly variable in *S. michoacensis*. Stickel presented data on all 18 specimens of *S. michoacensis* (including *S. aequalis*) then known but was able to examine only 11 of these. The holotype of *S. m. michoacensis* was lost, and he designated a neotype (Fig. 2), and described *S. m. mutabilis*. The recent discovery of a specimen intermediate in color pattern to "typical" *S. m. michoacensis* and *S. aequalis* and the availability of 14 specimens of *S. michoacensis* collected over the 30 years since Stickel's paper have made possible a re-examination of the variation in color pattern of the species and a reassessment of the taxonomic status of *S. aequalis*. Al-



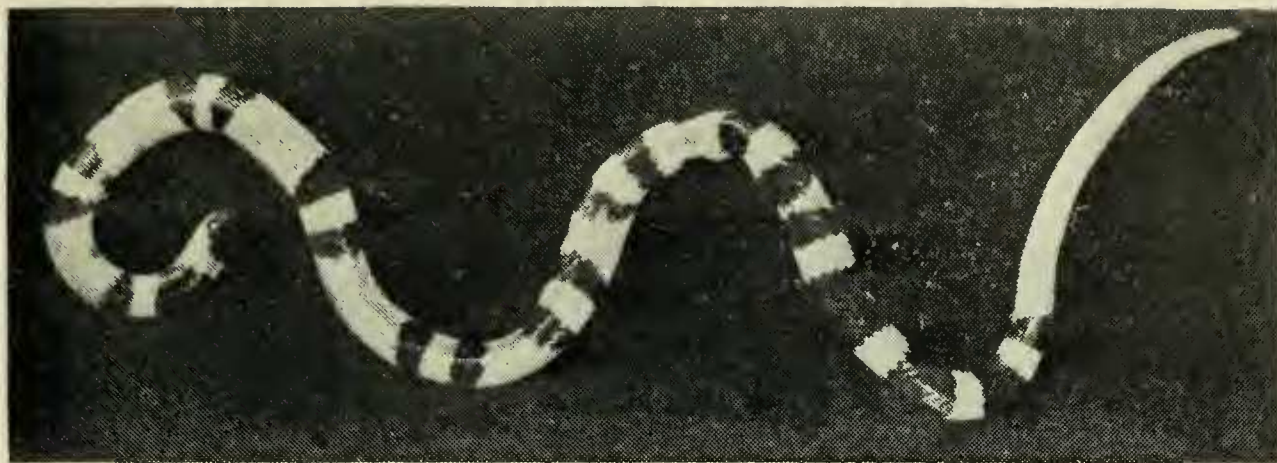


Figure 2. Neotype of *Sonora michoacanensis michoacanensis*, BMNH 1946. 1.14.65.

though this paper emphasizes color pattern, I have summarized meristic data for all known specimens (Tables 1 and 2) so that these data will be available to others. Counts of ventral scales were made according to the method of Dowling (1951) and do not include the anal scale. Counts of subcaudal scales exclude the tip. For these reasons, data given here may differ slightly from those presented by Stickel (1943: 114–115). Where means are given for scale counts they are based only upon specimens that I was able to examine myself. The color descriptions are based on preserved specimens unless stated otherwise.

*Acknowledgements.* William E. Duellman, Richard D. Estes, Ernest E. Williams and Richard G. Zweifel have all read the manuscript in its formative stages and I am grateful for their thoughtful criticism. The research was funded in part by a grant from the Boston University Graduate School (GRS BI-15-BIO). I am indebted to the following individuals and institutions for the loan of specimens: William E. Duellman (University of Kansas Museum of Natural History, KU), Herbert S. Harris (Personal Collection, RS-HSH), Hymen Marx (Field Museum of Natural History, FMNH), Hobart M. Smith and Dorothy Smith (University of Illinois Museum of Natural History, UIMNH), David B. Wake (Museum of Vertebrate Zoology, MVZ), Charles F. Walker and Scott M. Moody (University of Michigan Museum of Zoology, UMMZ), Ernest E. Williams (Museum of Comparative Zoology, MCZ) and Richard G. Zweifel (American Museum of Natural History, AMNH). Herbert S. Harris kindly provided a color slide of a living snake, and A. F. Stimson was instrumental in obtaining data

on, and photographs of, the three specimens in the British Museum of Natural History (BMNH). Photographs of other specimens were prepared by Frederick W. Maynard.

#### VARIATION OF COLOR PATTERN

It is almost impossible to exaggerate the extent of variation in color pattern exhibited by the series of *Sonora michoacanensis* presently available for study. Only the pattern of the head and neck seem relatively invariant. There is always a dark "mask" on an otherwise pale head. The mask may include the rostral and internasal scales, but typically begins between the rostral and a line connecting the anterior margins of the orbits. This dark area surrounds the eye and may extend forward on the side of the head to include all or parts of the nasal, loreal, preocular, anterior supralabials and those in contact with the orbit, the postorbitals and the temporals. Dorsally it covers the frontal, supraoculars and (often) parts of the prefrontals, terminating with a crescentic posterior margin on the parietals. There is a black or dark brown nuchal band (collar) separated from the mask by a light-colored band. The nuchal band may completely encircle the body or may be interrupted midventrally. The anterior margin of the nuchal band is variable in shape but the posterior margin is usually straight across. The nuchal band is followed posteriorly by a light-colored band, usually three to five scales wide, which is, in turn, followed by another dark band. The last is a "half-saddle," its anterior margin straight across and its posterior margin crescentic. The half-saddle may completely encircle the body or be interrupted at the midline below.

One specimen (FMNH 37141, Fig. 3A) has no pattern whatsoever except that just described. All others have some dorsal banding pattern. This overall dorsal pattern ranges from one of only saddle-shaped triads consisting of a median gray band abutted fore and aft by black (*e.g.*, AMNH 74951, Fig. 4B) to one of only broad black bands separated by a narrower gray band corresponding to the median gray band of the triads (*e.g.*, KU 106286, Fig. 4C–4D). Individual snakes may have combinations of triads and broad black bands (Fig. 3B, 3E–3F). Occasionally, the broad black bands are partially split by light pigment extending up from the venter (*e.g.*, MVZ 76714, Fig. 3B). The light pigment (= ground color) may be off-white, gray, salmon or flesh-colored but to comply with Stickel's



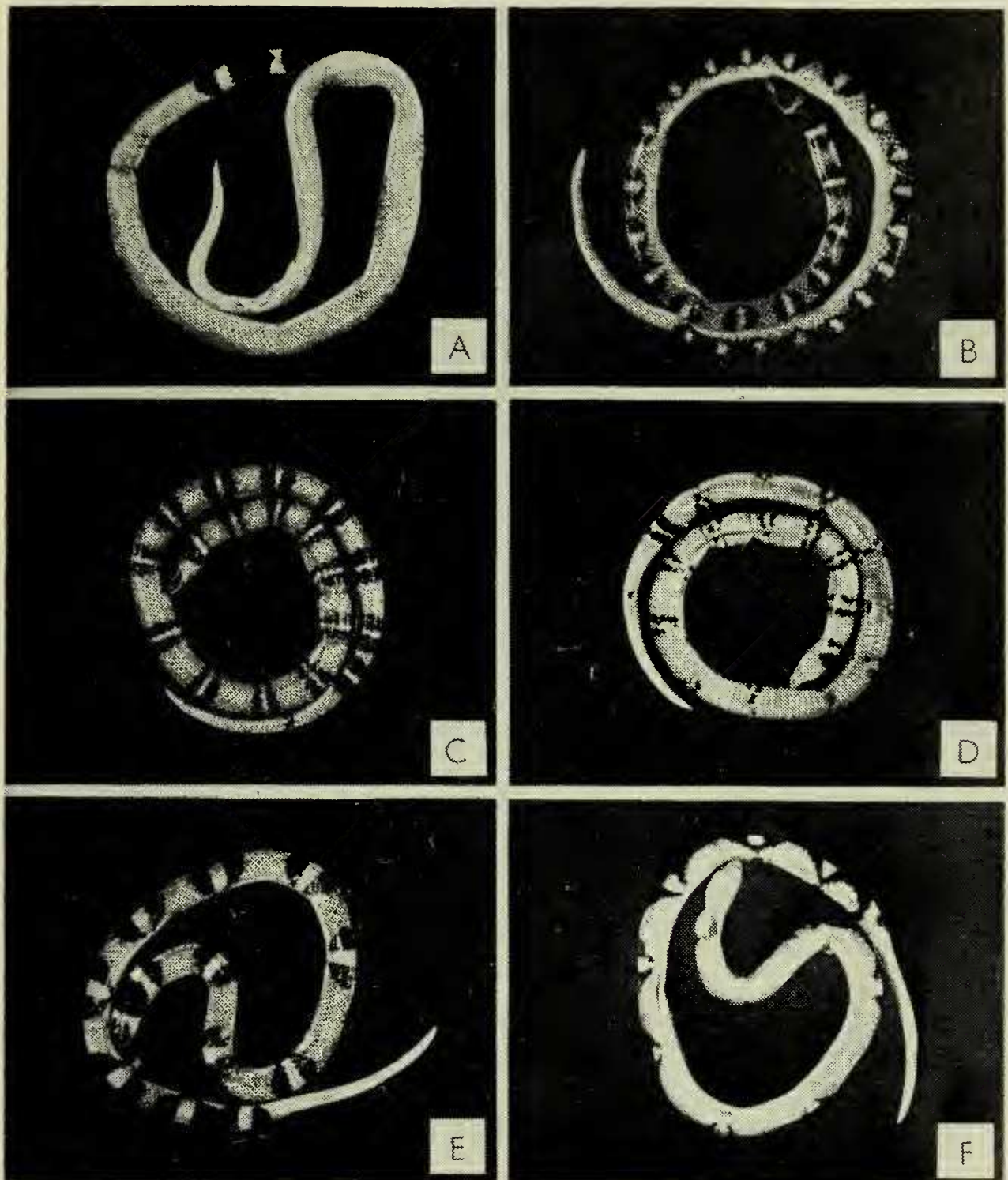


Figure 3. *Sonora michoacanensis michoacanensis*: A. FMNH 37141, dorsal; B. MVZ 76714, dorsal; C. UMMZ 109904, dorsal; D. UMMZ 109904, ventral; E. FMNH 39129, dorsal; F. FMNH 39129, ventral.

(1943) terminology it is referred to as red herein. The black bands may not reach the ventral scutes but if they do, they may or may not extend across them to form rings. The same is true for the black elements of the triads which may not reach the ventral scutes, may completely ring the body in such a way that the median gray band is also a ring, or may be joined along the midventral line so that the median gray band is incomplete. All three possibilities are seen on UMMZ 109904 (Fig. 3D). If a snake has both triads and broad black bands, it is usual for the triads to be found anteriorly and the black bands posteriorly (*e.g.*, FMNH 39129, Fig. 3E).

Taylor (1937) provides a description of color-in-life of *Sonora michoacanensis michoacanensis* from Guerrero and Jalisco. The ground color is red or pinkish, the dark elements of the triads black and the middle element of the triads yellow or gray-cream. A single specimen from Colima is similarly colored (Harris and Simmons, 1970), but Duellman (1961) described the middle element of the triads as white in a series of specimens from Michoacan.

A specimen of *Sonora michoacanensis michoacanensis* collected in Jalisco by Percy Clifton (KU 106286, Fig. 4C–4D) is unusual in that none of the black bands is split by red and there are no triads. None of the black bands except the nuchal and that immediately posterior to it reaches the ventral scutes. The broad black bands are expanded laterally just above the ventral scutes and some contact adjacent, similarly expanded bands. The black and gray bands (black and pale salmon in this specimen) are subequal in width. This pattern is approached in MVZ 76714 (Fig. 3B) but, prior to the discovery of KU 106286, no *S. michoacanensis* were known with a pattern entirely of unsplit black bands alternating with gray bands of approximately equal width. In this respect, KU 106286 resembles *Sonora aequalis* (MCZ 6444, Fig. 4E–4F).

In addition to presence or absence of caudal banding, *Sonora michoacanensis michoacanensis* and *S. m. mutabilis* differ in the number of gray bands of females, the number of complete triads of males, and the number of black bands unsplit by red of males and females. Sexual differences are evident for all three of these characters in *S. m. mutabilis*, but not in *S. m. michoacanensis* (Tables 1 and 2). In addition, there is a statistically significant ( $t = 3.91$ ,  $P < .01$  with 23 degrees of freedom) difference between the subspecies in total (left plus right) number of infralabials: The mean and standard devia-



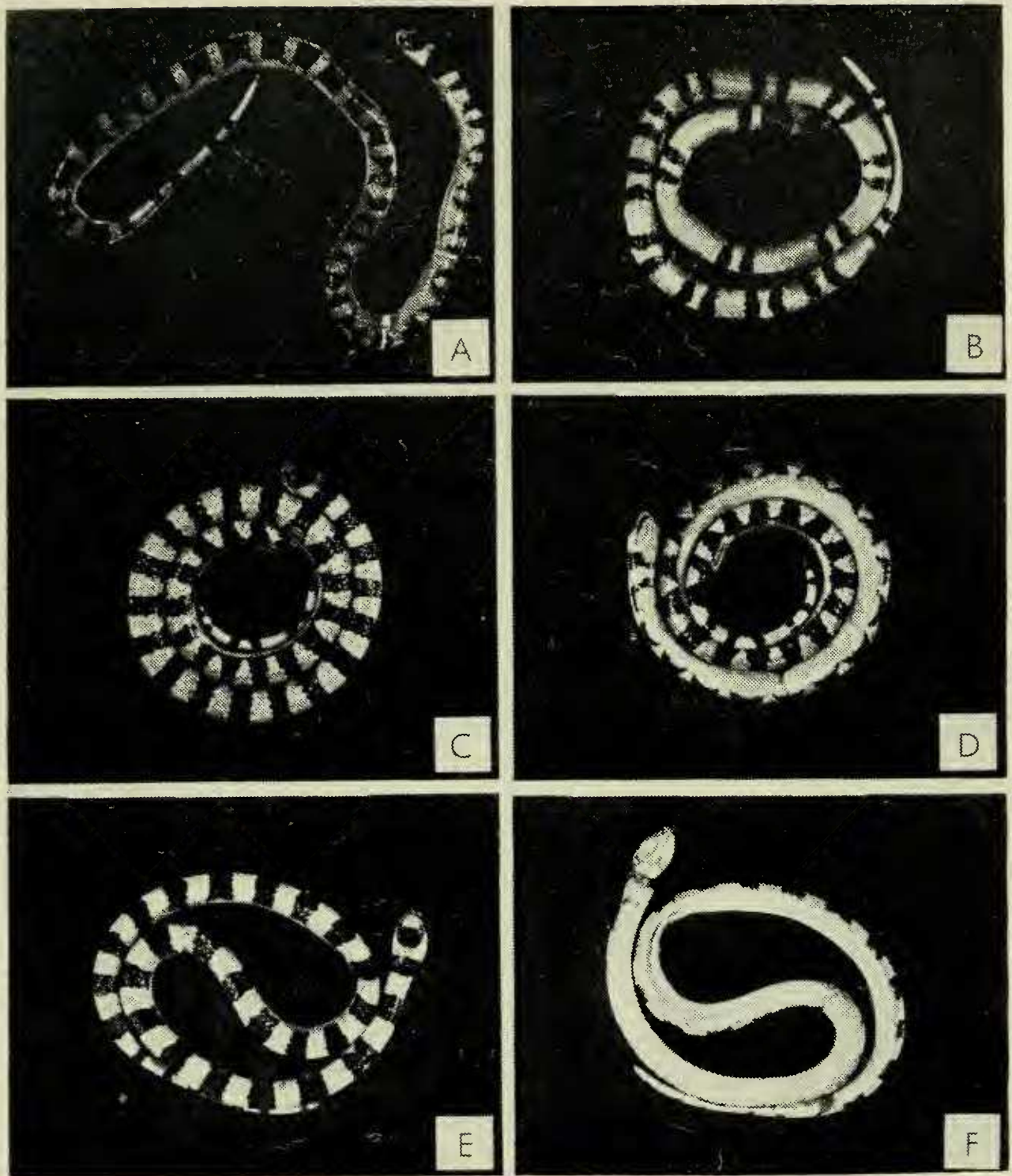


Figure 4. *Sonora michoacensis mutabilis*: A. UIMNH 18754, dorsal; B. AMNH 74951, dorsal; C. KU 106286, dorsal; D. KU 106286, ventral; E. MCZ 6444, dorsal; F. MCZ 6444, ventral. MCZ 6444 is the holotype of *Sonora aequalis*.

tions for *S. m. michoacanensis* are  $13.5 \pm 1.09$ , for *S. m. mutabilis*  $12.1 \pm 0.30$ . The number of infralabials is not sexually dimorphic for either subspecies. It is notable that of the seven *S. m. michoacanensis* with 13 fewer infralabials, three are from near Coalcomán, Michoacan (UMMZ 106604–6), where a single specimen (UMMZ 109904, Fig. 3C–3D) has one irregularly shaped caudal band, possibly indicative of intergradation. Three other specimens with fewer than 14 infralabials (KU 23791, MCZ 33650) or indications of low numbers of infralabials (MVZ 45123) are from near Chilpancingo, Guerrero. The seventh such specimen is the missing holotype from “Michoacan” [Cope, 1884(1885)].

#### THE TAXONOMIC STATUS OF *Sonora aequalis*

The only known specimen of *Sonora aequalis* (MCZ 6444)<sup>1</sup> is recorded as being from Matagalpa, Nicaragua, but Stickel (1943: 117) concluded that Matagalpa was most likely only the shipping point for material collected by W. B. Richardson. Other specimens in the same bottle as the snake and the locality label were two *Eumeces lynxe lynxe* (*vide* Joseph R. Bailey in Stickel, 1943: 118), a lizard whose range overlaps that of *Sonora michoacanensis mutabilis*. This and other evidence led Stickel to conclude that MCZ 6444 was found within or near the range of *S. m. mutabilis*. The pattern of MCZ 6444 consists of 26 black bands and 25 gray bands, the bands being all of approximately the same width (the basis for the name *aequalis*). None of the black bands is split by red but several are ventrally concave (Fig. 4F). The nuchal band completely rings the body, but details in this region are obscure because of damage to the specimen. None of the black bands on the body reaches the venter and none is expanded laterally as in KU 106286. The cephalic pattern is the same as that of *S. michoacanensis* and the tail is banded in triads as is characteristic of *S. m. mutabilis*. The specimen is badly faded and no colors other than black and gray are apparent.

In view of the great variation in dorsal body pattern evident within the subspecies of *Sonora michoacanensis*, it does not seem to me that the differences between *S. aequalis* and *S. m.*

---

<sup>1</sup>Stickel (1943: 117), in error, recorded the snake as an uncatalogued specimen in the University of Michigan Museum of Zoology. How and why it got to Michigan and thence back to the Museum of Comparative Zoology remains a mystery.



*mutabilis* are great enough to warrant taxonomic recognition of *S. aequalis*. These differences are certainly no more startling than those of the almost patternless FMNH 37141 (Fig. 3A). KU 106286 (Fig. 4C–4D) seems to be a logical intermediate in pattern between *S. m. mutabilis* and *S. aequalis*. Extensive collecting in México and Nicaragua over the last 30 years has brought to light no additional specimens of *S. aequalis*, but a number of additional specimens of “typical” (if that word is admissible) *S. michoacanensis* have been collected in México. Of course, no additional specimens similar to FMNH 37141 have been found either.

It may be questioned whether it is any more justifiable to “sink” a species on the basis of one specimen (KU 106286) than it was to name one in the first place (*S. aequalis*, MCZ 6444). But the discovery of KU 106286 has provided an important link in what appears to be a continuum in pattern variation extending from the pattern (or, rather, lack of pattern) exhibited by FMNH 37141 to that of MCZ 6444 with the presence or absence of caudal banding superimposed. The possibility that KU 106286 is a hybrid of *S. aequalis* and *S. m. mutabilis* cannot be ruled out, but its likelihood is reduced by the absence of additional specimens of *S. aequalis* in collections made over the past 30 years.

#### RELATIONSHIPS OF THE COMPONENTS OF COLOR PATTERN AND THE ORIGIN OF *Sonora michoacanensis*

Figure 5 illustrates my concept of the relationships of the various components of dorsal color pattern of *Sonora michoacanensis*. Certainly no ontogenetic sequence is implied, but the initial stages (Fig. 5A–5B) may be interpreted to suggest something of the origin of the species. The ancestor of *S. michoacanensis* may have been patterned very much like MCZ 6444. Progressive erosion of the broad black bands (Figs. 5B–5D) would yield triads (Fig. 5E). A complex genetic mechanism would allow individual snakes to have various combinations of triads and unsplit black bands or triads in varying numbers and of varying distances apart. With the exception of the virtually patternless FMNH 37141, the most consistent element of color pattern is the gray band between adjacent unsplit black bands or as the median element in a triad (Stickel, 1943: 116).

The banding pattern of MCZ 6444 is very similar to that of the banded forms belonging to the *Sonora semiannulata* group

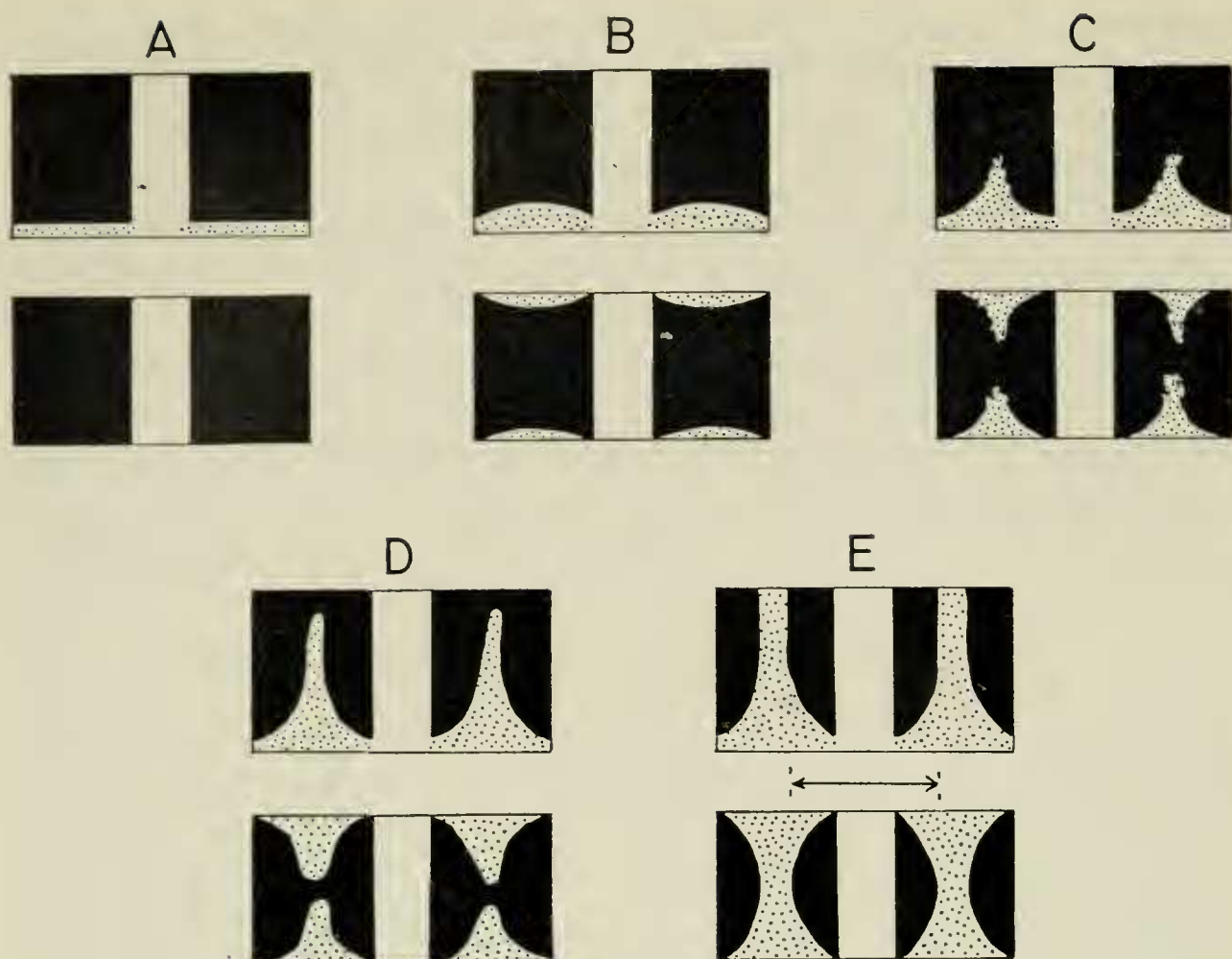


Figure 5. Diagrammatic representation of color pattern variation of *Sonora michoacanensis*. The arrow spans one complete triad. Black = black, white = white or yellow, stippled = red. Upper figure of each pair, lateral view; lower figure, dorsal view.

of southwestern United States and northern México (Stickel, 1938: 184–186; Stebbins, 1966). MCZ 6444 and all *Sonora michoacanensis* have 15 dorsal scale rows with no reduction as do some members of the *S. semiannulata* group. *Sonora michoacanensis* is distinguishable from members of the *S. semiannulata* group in morphology of the hemipenis (Stickel, 1943: 112), but the two groups are very similar in scutellation, teeth, dentigerous bone structure, microscopic scale striation and, generally, color pattern (Stickel, 1943: 110). It seems reasonable to assume that, as Stickel (1943: 118) seems to have suggested, *S. michoacanensis* had its origin within the *S. semiannulata* group or that the two groups had a common ancestor.

Members of the *Sonora semiannulata* group are presently found (Stebbins, 1966) in the southern Warm Temperate and Subtropical Climatic Zones as broadly mapped by Dorf (1959: 198). These major climatic belts shifted southward with glacial



advance during the Pleistocene (Dorf, 1959: 195) and the range of the *S. semiannulata* group or its ancestor may have been depressed southward into the area presently occupied by *S. michoacanensis*. *Sonora michoacanensis* may have differentiated as a relict at the southwestern fringe of the Mexican Plateau when climatic zones retreated northward with retraction of Wisconsin glaciation.

THE SELECTIVE SIGNIFICANCE OF THE COLOR PATTERN  
OF *Sonora michoacanensis*

A number of New World colubrid snakes have tricolor banding patterns which are reminiscent of the red, black and yellow or white patterns well known among the highly venomous coral snakes (Elapidae). Considerable circumstantial evidence has accumulated that the colubrids are mimics of those coral snakes with which they are sympatric and are thus avoided by those predators which have learned to avoid coral snakes (Dunn, 1954; Hecht and Marien, 1956; but see Brattsrom, 1955). Three kinds of mimicry in snakes have been recognized (Wickler, 1968: 118). Batesian mimicry where the model is highly venomous and the mimic nonvenomous, Müllerian mimicry where both models and mimics are highly venomous and reinforce one another, and Mertensian mimicry where the model is highly venomous and the mimic mildly venomous. *Sonora michoacanensis* is a Batesian mimic of coral snakes of the genus *Micrurus* (Hecht and Marien, 1956: 345).

The ranges of several species of *Micrurus* overlap or are contained within the range of *Sonora michoacanensis* (Roze, 1967). The basic color pattern of these elapids is one of black rings bordered on either side by narrower yellow or white rings, these triads being separated along the body by red. The order of the colors in the triads is, therefore, different from that of *S. michoacanensis*. This difference is probably of little significance insofar as mimicry is concerned, as the distinction is difficult to make, even for a trained observer, when the snakes are come upon suddenly or when they are moving. Potential predators presumably have the same difficulty and Hecht and Marien (1956: 339) present evidence that the order of the colors is less important than the presence of the bright, contrasting colors themselves. In other words, the mimic need not be an exact replica of the model to gain a selective advantage.

The concept of Batesian mimicry requires that the mimic be

less abundant than the model. If relative abundance in museum collections is an accurate reflection of relative abundance in nature, this requirement is met in that *Micrurus* is much better represented. It should, however, be noted that *Sonora michoacanensis* is a secretive species and may not be as rare as collections indicate. In a few areas where collecting has been repeated or intensive, small series have been obtained (see list of specimens).

There are two alternative hypotheses concerning the origin of mimicry: 1) The mimic evolves in a single step by mutation (Goldschmidt, 1945), and 2) the mimic evolves gradually through selection of modifier genes improving upon an original mutant that had itself a slight selective advantage (Fisher, 1930; E. B. Ford, 1953). Sheppard (1959) strongly supports the second hypothesis and suggests that mimetic patterns are controlled by supergenes that have evolved stepwise. Recent experimental work by H. A. Ford (1971) supports the alternative of gradual evolution and provides evidence that bird predators avoid a new partial mimic, strongly preferring a familiar non-mimetic form of prey.

If my interpretation is correct, *Sonora michoacanensis* evolved from a bicolor, banded ancestor belonging to the *S. semiannulata* group. Although bicolor members of this group are sympatric with a coral snake (*Micruroides euryxanthus*) over much of their range, relative numbers of specimens in museums suggests the colubrid to be much the commoner snake. Thus, Batesian mimicry could not develop. To the south, however, the Pleistocene relict population ancestral to *S. michoacanensis* may have been small relative to the populations of *Micrurus* with which they evolved. If this was indeed the case, *S. michoacanensis* may as yet have not been perfected as a mimic and should be considered as intermediate in an evolutionary sequence leading from a nonmimetic, bicolor, banded ancestor toward a snake with a pattern of only triads. As there seems to be no geographic trend in color pattern except the presence or absence of caudal bands and the generally better mimetic pattern of male *S. m. mutabilis* (see below), the gradual perfection of mimicry seems to be proceeding over the entire range of *S. michoacanensis*. The extreme variability in color pattern evident in the present population would result from lack of fixation at each of the major and minor gene loci responsible for pattern. This diversity of pattern would be tolerated because all of the intermediate types are to some degree mimetic except those that



have bicolor banding patterns (*e.g.*, MCZ 6444 and KU 106286) or are nearly patternless (*e.g.*, FMNH 37141). Such extremes are expected at low frequencies where inheritance is polygenic and where fixation has not occurred (Strickberger, 1968). The pattern of *S. michoacanensis* may be regarded as both protective in a mimetic sense and as concealing or disruptive (Brattstrom, 1955). Hecht and Marien (1956: 346) have suggested that, "Banding may be an intermediate step through which a disruptive pattern is converted to a ringed, warning pattern, but functioning in both ways." It seems equally likely that the disruptive stage is intermediate to banded and tricolor, warning patterns.

An interesting and unexplained observation is that male *Sonora michoacanensis mutabilis* are, by virtue of having more complete triads (Table 2), better mimics than females and than both sexes of *S. m. michoacanensis*. Among butterflies, mimetic patterns are often sex-limited to females, as are other, nonmimetic, polymorphisms (Sheppard, 1959: 137). E. B. Ford (1953) has attributed this phenomenon to the importance of visual stimuli in the courtship of butterflies. Females make a choice of mates largely on the basis of visual cues and Ford (1953: 68) reasons that a new color pattern in males might not stimulate a female to copulate. In moths, where olfactory courtship stimuli largely replace visual cues, both sexes may be polymorphic (Sheppard, 1959: 137). Noble (1937) reviewed the role of sense organs in the courtship of snakes and concluded that chemical and tactile senses play the primary roles in sex discrimination and courtship, respectively. Vision was found to be important only in that movement attracts snakes during the breeding season. Nothing at all is known of the behavior of *S. michoacanensis*, but it seems unlikely that the sexual dichromatism of *S. m. mutabilis* serves as an aid to sex discrimination or courtship. There are no clues as to why sexual dichromatism should be pronounced only in *S. m. mutabilis* and not in *S. m. michoacanensis*.

The color pattern variation exhibited by *Sonora michoacanensis* is at least equaled by that of *Sonora aemula* Cope of southern Sonora and Chihuahua, México (Bogert and Oliver, 1945: 374; Zweifel and Norris, 1955: 244; Nickerson and Heringhi, 1966: 136). *Sonora aemula* is rare in collections (Nickerson and Heringhi knew of only ten specimens), but it, like *S. michoacanensis*, is probably locally more abundant than collections indicate. Five of the known specimens were found

in or near Alamos, Sonora. The species is sympatric with both *Micruroides* and *Micrurus* and one specimen (*e.g.*, Arizona State University No. 6611; Nickerson and Heringhi, 1966, fig. 1) may have typical *Micruroides*-like triads (white-black-white), *S. michoacanensis*-like triads (black-white-black), or expanded triads (black-white-black-white-black) like some *Micrurus* from southern México and Guatemala. The area between the triads is red. Mimicry in *S. aemula* may be at the same stage of development as that which I have suggested for *S. michoacanensis*, as may mimicry in some species of the *venustissimus* and *annulatus* groups of the genus *Scaphiodontophis* in Central America (Taylor and Smith, 1943). *Scaphiodontophis* is a Batesian mimic of both *Micrurus* and the mildly colubrid *Erythrolamprus* (Hecht and Marien, 1956: 342).

#### KNOWN SPECIMENS OF *Sonora michoacanensis*

The holotype of *Contia michoacanensis* Dugès (Cope), 1884 (1885) (= *Sonora michoacanensis*) has been lost, and Stickel (1943: 113) designated BMNH 1946.1.14.65 as neotype. BMNH specimens have been recatalogued since Stickel's (1943) paper and both old and new catalogue numbers appear in the listing to follow. Stickel (1943: 115) examined an uncatalogued specimen of *S. m. mutabilis* in the American Museum of Natural History which was "tied with" (Stickel, 1943) AMNH 19714-19716, but the present whereabouts of this specimen is unknown (W. H. Stickel and R. G. Zweifel, personal communications). Zweifel (1956: 6) has questioned the locality data of all four specimens. They are said to have been collected in Distrito Federal, México, but this is far removed from the range of the subspecies as presently understood from well-documented specimens (Fig. 1) and they are given as "Locality Unknown" below. Stickel (1943) cited specimens in the collections of E. H. Taylor and H. M. Smith by field number. These specimens have all been deposited in museums, and both field numbers (preceded by "HMS") and museum catalogue numbers are given below.

*Sonora michoacanensis michoacanensis* (18). COLIMA: Between Tecomán and Boca de Apiza, RS 596 HSH. GUERRERO: Chilpancingo Region, KU 23790-1, MCZ 33650, MVZ 45123; 16 km S Taxco, UIMNH 25063 (HMS 5440, holotype of *Sonora erythrura* Taylor, 1937); locality unknown, unnumbered specimen in the Museo Alfredo Dugès,



Colegio del Estado Guanajuato. MICHOACAN: Apatzingán, FMNH 39128-9; Apatzingán, Hacienda California, FMNH 37141; 3.2 km E Coalcomán, 1364 m, UMMZ 109904-6; 12.2 km S Tzitzio, 1121 m, UMMZ 119457; 16 km S Uruapan, MVZ 76714; locality unknown, BMNH 1946.1.14.65 (formerly BMNH 1903.3.21, neotype), the holotype (presumed lost). PUEBLA: 10 km SE Matamoros, UIMNH 41688.

*Sonora michoacanensis mutabilis* (13). JALISCO: near Magdalena, FMNH 105296 (HMS 4659, paratype), FMNH 105257 (HMS 4661, holotype), UIMNH 18754 (HMS 4660, paratype); 6.5 km S Tecalitlan, MVZ 71356. NAYARIT: Jesus Maria, AMNH 74951. ZACATECAS: 8.8 km S Mayahua, 1212 m, KU 106286; Mezquital de Oro, BMNH 1946.1.14.63 (formerly BMNH 92.10.31.42, paratype), BMNH 1946.1.14.64 (formerly BMNH 91.10.31.43, paratype). LOCALITY UNKNOWN: AMNH 19714-6 (paratypes), specimen "tied with" AMNH 19714-6 (presumed lost), MCZ 6444 (holotype of *Sonora aequalis* Smith and Taylor).

#### LITERATURE CITED

- BOGERT, C. M., AND J. A. OLIVER. 1945. A preliminary analysis of the herpetofauna of Sonora. Bull. American Mus. nat. Hist., 83: 297-426.
- BRATTSTROM, B. H. 1955. The coral snake "mimic" problem and protective coloration. Evolution, 9: 217-219.
- COPE, E. D. 1884(1885). Twelfth contribution to the herpetology of tropical America. Proc. American phil. Soc., 22: 167-194.
- DORF, E. 1959. Climatic changes of the past and present. Contrib. Mus. Paleont. Univ. Michigan, 13: 181-210.
- DOWLING, H. G. 1951. A proposed standard system of counting ventrals in snakes. British J. Herp., 1: 97-99.
- DUELLMAN, W. E. 1961. The amphibians and reptiles of Michoacan, Mexico. Univ. Kansas Publ., Mus. nat. Hist., 15: 1-148.
- DUNN, E. R. 1954. The coral snake "mimic" problem in Panama. Evolution, 8: 97-102.
- FISHER, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Clarendon Press, xiv + 291 pp.
- FORD, E. B. 1953. The genetics of polymorphism in the Lepidoptera. Advance. Genet., 5: 43-87.
- FORD, H. A. 1971. The degree of mimetic protection gained by new partial mimics. Heredity, 27: 227-236.
- GOLDSCHMIDT, R. B. 1945. Mimetic polymorphism, a controversial chapter of Darwinism. Quart. Rev. Biol., 20: 147-164, 205-250.
- HARRIS, H. S., AND R. S. SIMMONS. 1970. A *Sonora michoacanensis michoacanensis* (Dugès) from Colima, Mexico. Bull. Maryland herp. Soc. 6: 6-7.

- HECHT, M. K., AND D. MARIEN. 1956. The coral snake mimic problem: A reinterpretation. *J. Morph.*, **98**: 335-365.
- NICKERSON, M. A., AND H. L. HERINGHI. 1966. Three noteworthy colubrids from southern Sonora, Mexico. *Great Basin Nat.*, **26**: 136-140.
- NOBLE, G. K. 1937. The sense organs involved in the courtship of *Storeria*, *Thamnophis* and other snakes. *Bull. American Mus. nat. Hist.*, **73**: 673-725.
- ROZE, J. A. 1967. A checklist of the New World venomous coral snakes (Elapidae). with description of new forms. *American Mus. Novitates*, No. 2287, 60 pp.
- SHEPPARD, P. M. 1959. The evolution of mimicry; a problem in ecology and genetics. *Cold Spring Harbor Symp. Quant. Biol.*, **24**: 131-140.
- SMITH, H. M., AND E. H. TAYLOR. 1945. An annotated checklist and key to the snakes of Mexico. *U. S. natl. Mus. Bull.*, No. 187, iv + 239 pp.
- STEBBINS, R. C. 1966. *A Field Guide to Western Reptiles and Amphibians*. Boston: Houghton Mifflin Co., xiv + 279 pp.
- STICKEL, W. H. 1938. The snakes of the genus *Sonora* in the United States and Lower California. *Copeia*, **1938**: 182-190.
- . 1943. The Mexican snakes of the genera *Sonora* and *Chionactis* with notes on the status of other colubrid genera. *Proc. biol. Soc. Washington*, **56**: 109-128.
- STRICKBERGER, M. W. 1968. *Genetics*. New York: The Macmillan Co., x + 868 pp.
- TAYLOR, E. H. 1937. A new snake of the genus *Sonora* from Mexico, with comments on *S. michoacanensis*. *Herpetologica*, **1**: 69-73.
- , AND H. M. SMITH. 1943. A review of American sibynophine snakes, with a proposal of a new genus. *Univ. Kansas Sci. Bull.*, **29**: 301-337.
- WICKLER, W. 1968. *Mimicry in Plants and Animals*. New York: World Univ. Lib., McGraw-Hill Book Co., 255 pp.
- ZWEIFEL, R. G. 1956. Additions to the herpetofauna of Nayarit, Mexico. *American Mus. Novitates*, No. 1953, 13 pp.
- , AND K. S. NORRIS. 1955. Contribution to the herpetology of Sonora, Mexico. *American Midl. Nat.*, **54**: 230-249.

---

ADDED IN PROOF: Mr. Scott M. Moody has kindly called my attention to an additional specimen of *Sonora michoacanensis mutabilis* obtained too late for inclusion in this study. The snake (UMMZ 131666) is typical of the subspecies and was found at Presa de El Molino, El Molino in Jalisco, México.



Table 1. Summary of selected meristic and pattern data for the 18 known specimens of *Sonora michoacanensis michoacanensis* (Dugès).

SPECIMEN	SEX	BODY LENGTH (MM)	TAIL LENGTH (MM)	NUMBER OF TEMPORALS (LEFT/RIGHT)	NUMBER OF SUPRALABIALS (LEFT/RIGHT)	SUPRALABIALS ENTERING EYE (LEFT/RIGHT)	NUMBER OF INFRALABIALS (LEFT/RIGHT)	VENTRALS EXCLUDING ANAL	CAUDALS EXCLUDING TIP	NUMBER OF GRAY BANDS	NUMBER OF BLACK BANDS NOT SPLIT BY RED	NUMBER OF COMPLETE TRIADS	SOURCE
HOLOTYPE	MALE	160	35	1-2/1-2	7/7	3-4/3-4	6/6	152 <sup>1</sup>	37(+?) <sup>1</sup>	8 OR 7 <sup>1</sup>	2	-	Cope, 1884 (1885); Stickel, 1943
BMM 1946, 1.14.55	MALE	244	56	-	-	-	-	165 <sup>1</sup>	44 <sup>1</sup>	12	3	8	Stickel, 1943; Stinson, personal communication
FTH 37141	MALE	205	50	1-2/1-1	7/7	3-4/3-4	7/7	152	44	1	0	0	Present study; Stickel, 1943
UIMH 25063	MALE	110	23	1-2/1-1	8/8	3-4/3-4	7/7	163	46	15	7	6	Present study; Stickel, 1943
KU 23790	MALE	237	46	1-2/1-2	7/7	3-4/3-4	7/7	177	41	16	11	3	Present study
KU 23791	MALE	275	55	1-1/1-1	7/6	3-4/2-3	7/6	175	42	15	5	8	Present study
UIMZ 119457	MALE	211	47	1-2/1-2	7/7	3-4/3-4	7/7	157	41	11	4	4	Present study
MEAN		206	44.6					164.8	42.8	11.7	4.6	4.8	
STANDARD DEVIATION		55.6	11.8					11.0	2.2	5.6	3.6	3.1	
STANDARD ERROR		21.0	4.4					4.9	0.97	2.3	1.4	1.3	
MUSEU DUGÈS	FEMALE	-	-	-	-	-	-	177 <sup>1</sup>	43 <sup>1</sup>	21	13	-	Stickel, 1943
FTH 39128	FEMALE	169	31	1-1/1-1	7/6	3-4/3-4	8/7	173	36	8	0	7	Present study; Stickel, 1943
FTH 39129	FEMALE	201	38	1-1/1-1	7/7	3-4/3-4	8/7	171	39	12	1	9	Present study; Stickel, 1943
MCZ 33650	FEMALE	272	58	1-2/1-2	7/7	3-4/3-4	6/7	175	46	18	10	6	Present study; Stickel, 1943
MCZ 45123	FEMALE	253	54	1-3/1-2	7/7	3-4/3-4	6/?	175	45	16	10	4	Present study
MCZ 76714	FEMALE	228	45	1-1/1-2	8/8	4-5/4-5	7/7	170	40	26	15	8	Present study
RS 596 HSH	FEMALE	220	36	1-1/1-2	7/7	3-4/3-4	7/7	161	32	16	5	8	Present study
UIMH 41688	FEMALE	257	51	1-2/1-2	6/6	3-4/3-4	7/7	177	40	19	9	5	Present study
UIMZ 109304	FEMALE	192	34	1-2/1-2	6/7	3-4/3-4	6/5	168	37	18	0	17	Present study
UIMZ 109305	FEMALE	234	41	1-2/1-2	7/7	3-4/3-4	6/7	171	38	20	7	10	Present study
UIMZ 109306	FEMALE	120	19	1-2/1-2	7/7	3-4/3-4	6/6	171	33	18	16	0	Present study
MEAN		215	40.7					171.2	38.6	17.4	7.8	7.4	
STANDARD DEVIATION		45.8	11.7					4.5	4.5	4.7	5.8	4.4	
STANDARD ERROR		14.5	3.7					1.4	1.4	1.4	1.7	1.4	

<sup>1</sup> NOT INCLUDED IN CALCULATED MEAN, STANDARD DEVIATION AND STANDARD ERROR.

SPECIMEN	SEX	BODY LENGTH (MM)	TAIL LENGTH (MM)	NUMBER OF TEMPORALS (LEFT/RIGHT)	NUMBER OF SUPRALABIALS (LEFT/RIGHT)	SUPRALABIALS ENTERING EYE (LEFT/RIGHT)	NUMBER OF INFRALABIALS (LEFT/RIGHT)	VENTRALS EXCLUDING ANAL	CAUDALS EXCLUDING TIP	NUMBER OF GRAY BANDS	NUMBER OF BLACK BANDS NOT SPLIT BY RED	NUMBER OF COMPLETE TRIADS	SOURCE
BETH 1946, 1.14.63	MALE	229	54	-	-	-	-	160 <sup>1</sup>	45 <sup>1</sup>	12	0	11	STICKEL, 1943; STIMPSON, PERSONAL COMMUNICATION
BETH 1946, 1.14.64	MALE	220	48	-	-	-	-	166 <sup>1</sup>	46 <sup>1</sup>	18	0	17	STICKEL, 1943; STIMPSON, PERSONAL COMMUNICATION
ARTH 19714	MALE	247	55	1-2/1-2	7/7	3-4/3-4	6/6	164	42	15	0	13	PRESENT STUDY; STICKEL, 1943
ARTH 19716	MALE	?	43	1-4/1-2	6/7	2-3/3-4	7/6	163	48	15	0	13	PRESENT STUDY; STICKEL, 1943
ARTH 74951	MALE	215	41	? / ?	7/7	3-4/3-4	6/6	171	40	14	0	13	PRESENT STUDY
FETH 105296	MALE	191	44	1-2/1-2	7/7	3-4/3-4	6/6	163	44	17	2	12	PRESENT STUDY; STICKEL, 1943
FETH 105297	MALE	184	43	1-2/1-2	7/7	3-4/3-4	6/6	161	44	15	0	14	PRESENT STUDY; STICKEL, 1943
MEZ 71358	MALE	19	15	1-2/1-2	7/7	3-4/3-4	6/6	171	34	13	1	9	PRESENT STUDY
MEAN		174	42.9					165.5	42.0	14.9	0.38	12.8	
STANDARD DEVIATION		48.4	12.4					4.4	4.7	2.0	0.7	2.3	
STANDARD ERROR		16.3	4.4					1.8	1.9	0.7	0.3	0.8	
ARTH 13715	FEMALE	173	31	1-1/1-1	7/7	3-4/3-4	6/6	173	38	31	25	3	PRESENT STUDY; STICKEL, 1943
ARTH ? <sup>2</sup>	FEMALE	-	-	-	-	-	-	173 <sup>1</sup>	43 <sup>1</sup>	27	23	-	STICKEL, 1943
KU 106281	FEMALE	230	45	1-2/1-2	5/7	1-2/3-4	6/6	178	43	33	32	0	PRESENT STUDY
MCZ 6444	FEMALE	225	40	1-2/1-2	7/7	3-4/3-4	6/6	174 <sup>1</sup>	38	25	26	0	PRESENT STUDY; STICKEL, 1943
UTAH 18754	FEMALE	210	42	1-2/1-2	7/7	3-4/3-4	6/6	169	41	26	17	6	PRESENT STUDY; STICKEL, 1943
MEAN		210	39.5					173.5	40.0	28.4	24.6	2.2	
STANDARD DEVIATION		16.8	6.0					4.5	2.4	3.4	5.4	2.9	
STANDARD ERROR		9.7	3.0					2.6	1.2	1.5	2.4	1.4	

<sup>1</sup>NOT INCLUDED IN CALCULATED MEAN, STANDARD DEVIATION AND STANDARD ERROR.

<sup>2</sup>SEE TEXT.

Table 2. Summary of selected meristic and pattern data for the 13 known specimens of *Sonora michoacanensis mutabilis* Stickel.